

What is claimed is:

1. A method for validating a flow calibration factor of a flow meter, comprising the steps of:

determining an initial flexural stiffness of a component of said flow meter;  
5       determining a current flexural stiffness of said component;  
      comparing said initial flexural stiffness to said current flexural stiffness; and  
      detecting a calibration error condition responsive to comparing said initial flexural  
stiffness to said current flexural stiffness.

10   2. The method of claim 1 further comprising the step of:

signaling said calibration error condition.

3. The method of claim 1 or 2 further comprising the step of:

correcting said flow calibration factor responsive to said calibration error condition  
15   being detected.

4. The method of claim 1 wherein said flexural stiffnesses are determined by solving a single degree of freedom model.

20   5. The method of claim 4 wherein said single degree of freedom model is solved using a method comprising the steps of:

applying a known force to said flow meter component;  
      measuring a resultant deflection of said flow meter component; and  
      determining said flexural stiffnesses responsive to said force and deflection.

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6. The method of claim 4 wherein said single degree of freedom model is solved using a method comprising the steps of:

determining a receptance transfer function;  
      calculating an inverse receptance frequency response; and  
30   determining said flexural stiffnesses responsive to said frequency response.

7. The method of claim 4 wherein said single degree of freedom model is solved using a method comprising the steps of:

identifying constants;  
applying a transfer function model to a complex frequency response;  
converting said transfer function from a mobility form to a response form;  
extracting modal parameters from said transfer function; and  
5 calculating flexural stiffnesses responsive to said modal parameters.

8. The method of claims 6 or 7 wherein said transfer function is determined using a multi-sine excitation method, comprising the steps of:

determining measurement frequencies of interest;  
10 defining a multi-sign excitation signal;  
performing a crest factor minimization;  
defining a total measurement time;  
defining a total number of averages  
applying said multi-sine to the input of said flow meter component;  
15 measuring a resultant output responsive to said multi-sine input; and  
determining said transfer function responsive to said multi-sine input and said resultant output.

9. The method of claim 1 wherein said flexural stiffnesses are determined by solving a  
20 multiple degree of freedom model.

10. The method of claim 9 wherein said method of solving a multiple degree of freedom problem comprises the steps of:

generating a response model of said flow meter structure;  
25 converting said response model to a modal model;  
converting said modal model into a spatial model; and  
determining said flexural stiffness from said spatial model.

11. The method of claim 9 wherein said calibration error is corrected using coefficient  
30 estimation techniques.

12. The method of claim 9 wherein said calibration error is corrected using multi-fluid calibration techniques.

13. The method of claim 9 wherein said calibration error is corrected using trending techniques.

14. The method of claim 10 wherein said step of generating a response model further 5 comprising the step of normalizing model data.

15. The method of claim 14 wherein said normalizing step comprises the steps of: 10 normalizing said model data with respect to a resonant frequency; normalizing said model data with respect to a reference temperature; and normalizing said model data with respect to a response variable.

16. The method of claim 15 wherein said response variable is displacement.

17. A system for validating a flow calibration factor of a flow meter comprising: 15 means for determining an initial flexural stiffness of a component of said flow meter; means for determining a current flexural stiffness of said component; means for comparing said initial flexural stiffness to said current flexural stiffness; and 20 means for detecting a calibration error condition responsive to comparing said initial flexural stiffness to said current flexural stiffness.

18. The system of claim 17 wherein said system further comprises a means for signaling 25 said calibration error condition.

19. The system of claims 17 or 18 wherein said system further comprises a means for 30 correcting said flow calibration factor error condition.

20. The system of claim 17 wherein said means for determining said flexural stiffnesses 30 comprises a means for solving a single degree of freedom model.

21. The system of claim 20 wherein said means for solving said single degree of 35 freedom model comprises:

means for applying a known force to said flow meter component;  
means for measuring a resultant deflection of said flow meter component; and  
means for determining said flexural stiffnesses responsive to said force and  
deflection.

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22. The system of claim 20 wherein said means for solving said single degree of freedom model comprises:

means for determining a receptance transfer function;  
means for calculating an inverse receptance frequency response; and

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means for determining said flexural stiffnesses responsive to said frequency response.

23. The system of claim 20 wherein said means for solving said single degree of freedom model comprises:

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means for identifying constants;  
means for applying a transfer function model to a complex frequency response;  
means for converting said transfer function from a mobility form to a response form;  
means for extracting modal parameters from said transfer function; and  
means for calculating flexural stiffnesses responsive to said modal parameters.

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24. The system of claims 22 or 23 wherein said transfer function is determined using a multi-sine excitation means, said multi-sine excitation means comprising:

means for determining measurement frequencies of interest;

means for defining a multi-sign excitation signal;

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means for performing a crest factor minimization;

means for defining a total measurement time;

means for defining a total number of averages

means for applying said multi-sine to the input of said flow meter component;

means for measuring a resultant output responsive to said multi-sine input; and

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means for determining said transfer function responsive to said multi-sine input and said resultant output.

25. The system of claim 17 wherein said means for determining said flexural stiffnesses comprises a means for solving a multiple degree of freedom model.

26. The system of claim 25 wherein said means for solving a multiple degree of freedom problem comprises:

means for generating a response model of said flow meter structure;  
5 means for converting said response model to a modal model;  
means for converting said modal model into a spatial model; and  
means for determining said flexural stiffness from said spatial model.

27. The system of claim 19 wherein said means for correcting said flow calibration error  
10 corrects using coefficient estimation techniques.

28. The system of claim 19 wherein said means for correcting said flow calibration error corrects using multi-fluid calibration techniques.

15 29. The system of claim 19 wherein said means for correcting said flow calibration error corrects using trending techniques.

30. The system of claim 25 wherein said means for generating a response model further comprises a means for normalizing model data.

20 31. The system of claim 30 wherein means for normalizing model data further comprises:

means for normalizing said model data with respect to a resonant frequency;  
means for normalizing said model data with respect to a reference temperature; and  
25 means for normalizing said model data with respect to a response variable.

32. The system of claim 31 wherein said response variable is displacement.

33. The system of claim 31 wherein said response variable is acceleration.